Herbarium collections – an invaluable resource for gall midge taxonomists

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Introduction

Leptospermum laevigatum (Gaertn.) F.Muell. (Myrtaceae), coast tea-tree is a bushy shrub native to coastal regions in south-eastern Australia (Lynn 1996). Following its use in dune stabilization programs and horticulture *L. laevigatum* became naturalized in some western Victorian coast and inland areas, Queensland, South Australia, Tasmania and Western Australia, where it is now considered a serious environmental weed (Burrell 1981; Lam & van Etten 2002; Adair *et al.* 2008). Dorchin and Adair (2010) described two new species of gall midge from the genus *Dasineura* (Diptera: Cecidomyiidae) inducing galls on *L. laevigatum* that cause severe malformation of buds, thereby preventing fruit set and seed formation. One species, *Dasineura tomentosa* Dorchin, induces galls broadly ovate-spherical in shape (Fig.1) formed by imbricate bracts that are tomentose-silky with appressed white hairs (Dorchin & Adair 2010). According to Dorchin and Adair (2010), *D. tomentosa* galls have been observed on *L. laevigatum* from northern New South Wales through to Nelson, Victoria, but it is likely to occur more extensively in eastern Australia.

Examination of herbarium specimens has previously been used for assessment of distribution of the gall midge *Rhopalomyia lawrenciae* Kolesik causing inflation of leaves of *Lawrencia squamata* Nees in Lehm. (Malvaceae) in South Australian saltmarshes (Kolesik 1998), *Asphondylia floriformis* Veenstra-Quah & Kolesik and *A. sarcocorniae* Veenstra-Quah & Kolesik infesting the beaded glasswort *Sarcocornia quinqueflora* (Bunge ex Ung.–Stern.) A.J. Scott (Veenstra-Quah *et al.* 2007), and *Asphondylia tecticorniae* Veenstra & Kolesik or *A. peelei* Veenstra & Kolesik on the shrubby glasswort *Tecticornia arbuscula* (R.Br.) K.A.Sheph. & Paul G.Wilson (Veenstra *et al.* 2011). Parasitoid wasps often attack cecidomyiids, for example *Asphondylia floriformis* and *A. tecticorniae* (Veenstra *et al.* 2011), and can be found in the galls caused by these gall midge species. Population densities of *D. tomentosa* are known to be regulated by parasitiod wasps (Dorchin & Adair 2010), by infecting and killing the developing gall midge larvae.

Herbarium collections of *L. laevigatum* were examined for the presence of *D. tomentosa* galls to find where this gall midge's occurrence has

Abstract

Dasineura tomentosa is a gall midge inducing distinctive galls on *Leptospermum laevigatum*. An efficient way of determining the geographic distribution of a gall midge is to examine herbarium specimens for the presence of galls inadvertently collected with the plant specimen. Of the 446 herbarium specimens of *L. laevigatum* examined 40 had galls caused by *D. tomentosa*, and two of the three galls examined in detail contained a parasitoid wasp. Despite some limitations, herbarium collections are an invaluable resource for insect taxonomists.

Keywords: Herbarium specimens, galls, gall midge, *Dasineura*

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Figure 1. Galls on *Leptospermum laevigatum* growing in Queenscliff, Victoria caused by the gall midge *Dosineuro tomentoso*. Mature galls 8 – 15 mm long and 7 – 12 mm wide. (Photo. Peter Kolesik).

inadvertently been recorded, and to determine whether there was any evidence of parasitoid wasp attack.

Materials & Methods

The geographic distribution of *D. tomentosa* was assessed by looking for their distinctive galls on specimens of *L. laevigatum* lodged in the National Herbarium of Victoria, (MEL) (*n* = 178), National Herbarium Canberra (CANB) (*n* = 123), Western Australian Herbarium (PERTH) (*n* = 62), and the State Herbarium of South Australia, Adelaide (AD) (*n* = 83). All herbarium specimens with galls present were annotated.

To investigate whether *D. tomentosa* had been attacked by parasitoid wasps, a single gall from three different *L. laevigatum* herbarium specimens (two were collected in the 1800s and the third in 1963) with a large number of galls present was carefully removed, dissected and photographed using an Olympus SZX16 stereo microscope with a digital camera.

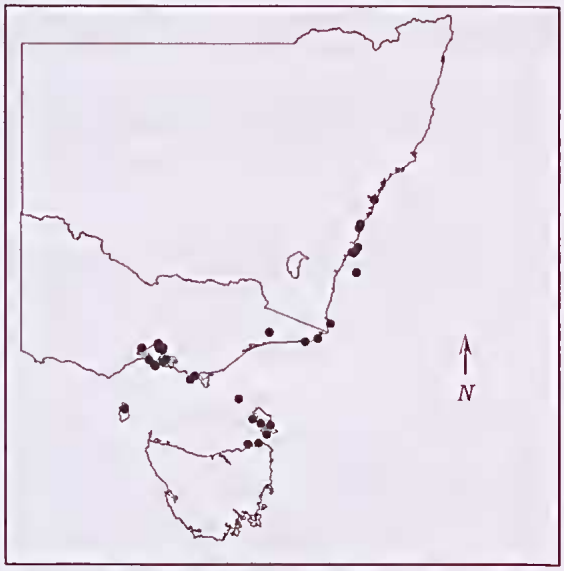

Figure 2. Distribution of *Dasineuro tomentosa* in southern Australia based on herbarium specimens of *Leptospermum laevigotum* with galls.

Results

Of the 446 specimens of *L. laevigatum* examined 40 had galls caused by *Dasineura tomentosa* – Adelaide (AD) (*n* = 1), Melbourne (MEL) (*n* = 20) and Canberra (CANB) (*n* = 19) (Table 1 and Fig. 2). The oldest plant specimen was collected from New South Wales by S. Johnson in 1875 (Fig. 3). As can be seen from dates of collections, gall formation is not a recently introduced phenomenon. The distribution of *Dasineura tomentosa* was described by Dorchin and Adair (2010) as being widespread in south eastern Australia, in coastal and near coastal habitats. This was similar to that ascertained using this method, with additional occurrences recorded from islands off the coast of Tasmania and Bowen Island off the coast of New South Wales.

The galls removed from herbarium specimens collected in1875 and 1963 both contained similar parasitiod wasps (Fig. 4). The third gall from a *L. laevigatum* specimen collected in 1887, contained *D. tomentosa* pupae still within the characteristic white silky cocoons formed on the outer bracts of the gall (Fig. 5).

Figure 3. Herbarium sheet (MEL2136272) with *Leptospermum laevigatum* specimen collected in East Gippsland by W.A. Sayer in 1887. Arrows indicate galls caused by the gall midge *Dasineura tomentosa*. Scale bar = 10 mm.

Table 1. Herbarium specimens of *Leptospermum laevigatum* with galls caused by *Dasineura tomentosa* held in Adelaide (AD) (n = 1), Melbourne (MEL) (n = 20) and Canberra (CAN8) (n = 19) with year of collection, collector and locality where specimens were collected.

Collection year	Collector	Locality	Herbarium ID
1875	S. Johnson	N.S.W.	MEL2136261
1882	E. Spong	King Island, Tasmania	MEL2137195
1882	C. alter	Port Phillip, Melbourne, Victoria	CANB398341
1884	Hon. Judge Dobson	Deal Island, Kents Group, Tasmania	MEL2136316
1885	D. McAlpine	8righton, Port Phillip, Victoria	MEL2136215
1887	W.A. Sayer	East Gippsland, Victoria	MEL2136272
1887	J. Minchin	Domain near 8otanic Museum, Melbourne, Victoria	MEL2136239
1930	H. Porter	Avalon, N.S.W.	CAN8395095
1949	C.W.E. Moore	Woollongong, N.S.W.	CANB24896
1949	J. Common	Jervis Bay, N.S.W.	CANB21615
1963	J.D.M. Pearson	Point Nepean, Victoria	MEL574903
1963	J.D.M. Pearson	Portsea, Victoria	MEL574905
1964	C.S. Rawlinson	Shoalhaven Heads, N.S.W.	CANB24176
1966	E.J. Carroll	8alnarring, Victoria	CAN815951
1966	E.J. Carroll	Cape Schanck, Victoria	CAN815952
1968	R.Pullen	South of Kiama, N.S.W.	CAN8314280
1969	C. Dunlop	Cape Liptrap, Victoria	CAN852159
1970	I. 8eeton	Portsea, Victoria	CAN839729
1971	N.E. Phillips	Waratah Bay, Victoria	MEL2136307
1971	M.E. Phillips	Waratah Bay, Victoria	CANB56527
1975	W.M. Curtis	Trousers Point, Flinders Island, Tasmania	MEL598207
1975	J.S. Whinray	Big Bog Island, Furneaux Group, Tasmania	CANB480995
1976	J.S. Whinray	Clarkes Island, Furneaux Group, Tasmania	MEL530296
1976	J. Piggin	Long Island Point, Victoria	CAN8610348
1979	M. Kenny	Edithvale, Victoria	AD97909172
1980	J. Taylor	Bowen Island, N.S.W.	CAN88008284
1980	R. Hart	Jervis 8ay, N.S.W.	CANB8005705
1983	A. Moscal	Petal Point, Tasmania	MEL104939
1985	G. Lucas	East Gippsland, Victoria	MEL684468
1987	Unknown	Clayton South, Victoria	MEL2016753
1991	A. M. Lyne	Lobster Bay, N.S.W.	CAN89105002
1991	D. E. Albrecht	Croajiingolong National Park, East Gippsland, Victoria	CANB9217301
1995	R. P. Cameron	Lower Snowy River, N.S.W.	MEL2136302
1998	A. J. Whalen, G. T. Chandler & S. Fethers	8en 8oyd National Park, N.S.W.	CANB9909907
2002	S. Harris	Waterhouse Island, Tasmania	MEL2203854
2002	S. Harris & A. Connolly	Waterhouse Island, Tasmania	MEL2203852
1960s	J.S. Whinray	Sealion Island, Furneaux Group. Tasmania	MEL2112101
1960s	J.S. Whinray	Penguin Island, Tasmania	CANB554972
ND	T.E. George	8lack Rock, Victoria	MEL2030715
ND	Unknown	Little River, Victoria	MEL2137197

Discussion

The reliability of this method for determining geographic distribution has obvious limitations in that the absence of galls on herbarium specimens does not necessarily mean that there were no gall midges at a particular location. Firstly, because the time of collection may preclude the presence of galls, and secondly, the plant material chosen by a collector may not include 'abnormal' growths. The specimens selected and the way in which some herbarium specimens were mounted by some early collectors e.g. S. Johnson in 1875 (Fig. 3) suggest that the collector may have mistaken the *D. tomentosa* galls for *L. laevigatum* flower buds. In fact one twentieth century collector selected a *L. laevigatum* specimen with many galls and commented on the 'large flowers' while another noted that the flowers on the specimen were 'abnormal'.

Despite these limitations, herbarium collections do provide information that is invaluable for both botanists and gall midge taxonomists. In addition to determining a gall midge's geographic distribution over time, sites for collection of specimens for taxonomic purposes can

Figure 4. Galls caused by *Dasineura tomentosa* removed from herbarium specimens of *Leptospermum laevigatum* collected in1875 and 1963 both contained similar parasitiod wasps.

Figure 5. A dissected gall from a *Leptospermum laevigatum* specimen collected in 1887, with *D. tomentosa* pupa (indicated by arrow) still within the characteristic white silky cocoons formed on the outer bracts of the gall.

be ascertained if the collector has recorded the month a plant specimen was collected. In the case of cecidomyiid gall midges, their parasitoid predators may also be present in galls on herbarium specimens, in sufficiently good condition for hymenopteran taxonomists to be able to positively identify them to species level. It would therefore be useful to encourage the collection of both 'typical' and 'aberrant' plant material for inclusion as herbarium vouchers.

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